Problem-based learning

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A PBL group at Sydney Dental Hospital

Problem-based learning (**PBL**) is a student-centered pedagogy in which students learn about a subject through the experience of solving an open-ended problem found in trigger material. The PBL process does not focus on problem solving with a defined solution, but it allows for the development of other desirable skills and attributes. This includes knowledge acquisition, enhanced group collaboration and communication. The PBL process was developed for medical education and has since been broadened in applications for other programs of learning. The process allows for learners to develop skills used for their future practice. It enhances critical appraisal, literature retrieval and encourages ongoing learning in a team environment.

The PBL tutorial process involves working in small groups of learners. Each student takes on a role within the group that may be formal or informal and the role often rotates. It is focused on the student's reflection and reasoning to construct their own learning. The Maastricht seven-jump process involves clarifying terms, defining problem(s), brainstorming, structuring and hypothesis, learning objectives, independent study and synthesis. In short, it is identifying what they already know, what they need to know, and how and where to access new information that may lead to the resolution of the problem. The role of the tutor is to facilitate learning by supporting, guiding, and monitoring the learning process.[1] The tutor must build students' confidence to take on the problem, and encourage the students, while also stretching their understanding. This process is based on constructivism. PBL represents a paradigm shift from traditional teaching and learning philosophy,[2] which is more often lecture-based. The constructs for teaching PBL are very different from traditional classroom or lecture teaching and often requires more preparation time & resources to support small group learning.

Contents

Meaning

Wood (2003) defines Problem-based learning as a process that uses identified issues within a scenario to increase knowledge and understanding.[3] The principles of this process is listed below:

1. Learner-driven self-identified goals and outcomes
2. Students do independent, self-directed study before returning to larger group
3. Learning is done in small groups of 8–10 people, with a tutor to facilitate discussion
4. Trigger materials such as paper-based clinical scenarios, lab data, photographs, articles or videos or patients (real or simulated) can be used
5. The Maastricht 7 jump process helps to guide the PBL tutorial process
6. Based on principles of adult learning theory
7. All members of the group have a role to play
8. Allows for knowledge acquisition through combined work and intellect
9. Enhances teamwork and communication, problem-solving and encourages independent responsibility for shared learning - all essential skills for future practice

History

The PBL process was pioneered in medical school programs McMaster University in Hamilton. Traditional medical education disenchanted students, who perceived the vast amount of material presented in the first three years of medical school as having little relevance to the practice of medicine and clinically based medicine.[4]

The PBL curriculum was developed in order to stimulate learning by allowing students to see the relevance and application to future roles. It maintains a higher level of motivation towards learning, and shows the importance of responsible, professional attitudes with teamwork values.[4] The motivation for learning drives interest because it allows for selection of problems that have real-world application.

Problem-based learning has subsequently been adopted by other medical school programs,[4] adapted for undergraduate instruction,[5][6][7] as well as K-12.[4][8] The use of PBL has expanded from its initial introduction into medical school programs to include education in the areas of other health sciences, math, law, education, economics, business, social studies, and engineering.[8] PBL includes problems that can be solved in many different ways depending on the initial identification of the problem and may have more than one solution.[9]

Advantages

There are advantages of PBL. It is student-focused, which allows for active learning and better understanding and retention of knowledge. It also helps to develop life skills that are applicable to many domains.[10] It can be used to enhance content knowledge while simultaneously fostering the development of communication, problem-solving, critical thinking, collaboration, and self-directed learning skills.[11][12] PBL may position students to optimally function using real-world experiences. By harnassing collective group intellect, differing perspectives may offer different perceptions and solutions to a problem.

Disadvantages

According to Wood (2003), the major disadvantage to this process involves the utilization of resources and tutor facilitation. It requires more staff to take an active role in facilitation and group-led discussion and some educators find PBL facilitation difficult and frustrating. It is resource-intensive because it requires more physical space and more accessible computer resources to accommodate simultaneous smaller group-learning.[13] Students also report uncertainty with information overload and are unable to determine how much study is required and the relevance of information available. Students may not have access to teachers who serve as the inspirational role models that traditional curriculum offers.[13]

Constructivism and PBL

Problem-based Learning addresses the need to promote lifelong learning through the process of inquiry and constructivist learning.[1] PBL is considered a constructivist approach to instruction because it emphasizes collaborative and self-directed learning while being supported by tutor facilitation.[14] Yew and Schmidt,[15] Schmidt, and Hung elaborate on the cognitive constructivist process of PBL:[1][2]

1. Learners are presented with a problem and through discussion within their group, activate their prior knowledge.
2. Within their group, they develop possible theories or hypotheses to explain the problem. Together they identify learning issues to be researched. They construct a shared primary model to explain the problem at hand. Facilitators provide scaffold, which is a frame work on which students can construct knowledge relating to the problem.
3. After the initial teamwork, students work independently in self-directed study to research the identified issues.

4. The students re-group to discuss their findings and refine their initial explanations based on what they learned.

PBL follows a constructivist perspective in learning as the role of the instructor is to guide and challenge the learning process rather than strictly providing knowledge.[16][17] From this perspective, feedback and reflection on the learning process and group dynamics are essential components of PBL. Students are considered to be active agents who engage in social knowledge construction. PBL assists in processes of creating meaning and building personal interpretations of the world based on experiences and interactions.[18] PBL assists to guide the student from theory to practice during their journey through solving the problem.[19]



A PBL group at Gadjah Mada University

Supporting evidence

Several studies support the success of the constructivist problem-based and inquiry learning methods.[20] One example is a study on a project called GenScope, an inquiry-based science software application, which found that students using the GenScope software showed significant gains over the control groups, with the largest gains shown in students from basic courses.[20]

One large study tracked middle school students' performance on high-stakes standardized tests to evaluate the effectiveness of inquiry-based science.[20] The study found a 14 percent improvement for the first cohort of students and a 13 percent improvement for the second cohort.[20] The study also found that inquiry-based teaching methods greatly reduced the achievement gap for African-American students.[20]

A systematic review of the effects of problem-based learning in medical school on the performance of doctors after graduation showed clear positive effects on physician competence. This effect was especially strong for social and cognitive competencies such as coping with uncertainty and communication skills.[21]

Another study from Slovenia looked at whether students who learn with PBL are better at solving problems and if their attitudes towards mathematics were improved compared to their peers in a more traditional curriculum. The study found that students who were exposed to PBL were better at solving more difficult problems, however, there was no significant difference in student attitude towards mathematics.[9]

Examples of PBL in curricula

Malaysia & Beyond

In Malaysia, an attempt is being made to introduce a problem-based learning model in secondary mathematics, with the aim of educating citizens to prepare them for decision-making in sustainable and responsible development. This model called Problem-Based Learning the Four Core Areas (PBL4C) (https://pbl4c.wordpress.com/) first sprouted in SEAMEO RECSAM in 2008, and as a result of training courses conducted, a paper[22] was presented at the EARCOME5 (http://www.sme.or.jp/earcome/paper_presentation.pdf) conference in 2010, followed by two papers during the 15th UNESCO-APEID

(http://www.unescobkk.org/education/apeid/apeid-international-conference/apeidconf11/papers-and-presentations) conference in 2011. This model has been introduced to the field of education management, Education for International & Intranational Understanding (EIU), and human resource management, among educators from countries, in & beyond Malaysia, affiliated with SEAMEO RECSAM. Several Malaysian universities had begun implementing PBL in their curricula in an effort to improve the quality of their education. In collaboration with Aalborg University of Denmark, PBL was introduced at University Tun Hussein Onn Malaysia (UTHM). Since then the PBL was widely used among engineering and as well as humanities lecturers at UTHM (Berhannudin, 2007). In Universiti Malaya, the Bachelor of Medicine, Bachelor of Surgery and Bachelor of Dental Surgery courses included several sessions of problem-based learning in their curriculum as a way of teaching interactions between students.

Medical schools

Several medical schools have incorporated problem-based learning into their curricula following the lead of McMaster University Medical School, using real patient cases to teach students how to think like a clinician. More than eighty percent of medical schools in the United States now have some form of problem-based learning in their programs.[23] Research of 10 years of data from the University of Missouri School of Medicine indicates that PBL has a positive effect on the students' competency as physicians after graduation.[21]

Monash University was the second institution to adopt PBL within a medical school environment and continues to apply this within the Faculty of Medicine, Nursing and Health Sciences for the Bachelor of Medicine / Bachelor of Surgery (MBBS) programs delivered in Australia and Malaysia.

Maastricht University offers its whole program in PBL format only, as does St. George's University of London, another pioneer in the PBL format. The University of Limerick graduate entry medical school in Ireland followed by adapting the SGUL program as well as other programs to also provide its program in PBL format only. In 1983 the college of medicine and medical sciences was founded in Bahrain as part of the Arabian Gulf University. It adopts a problem-based learning curriculum from the beginning and offers its MD program in PBL only. In 1998, Western University of Health Sciences opened its College of Veterinary Medicine, with curriculum based completely on PBL.[24]

In 2002, UC Berkeley – UCSF Joint Medical Program (JMP), an accredited five year Master of Science/Medical Doctorate Program housed at University of California, Berkeley School of Public Health, began offering a 100% case based curriculum to their students in their pre-clerkship years. The curriculum integrates the basic and preclinical sciences while fostering an understanding of the biological, social, and moral contexts of human health and disease. The students spend their last two clerkship years at University of California, San Francisco.[25]

Peninsula College of Medicine and Dentistry (South West England), set up its medical BMBS course based around PBL in 2002. Peninsula offered a fully integrated course that prepared students for life as a doctor, with early exposure to clinical experiences and opportunities to discuss them through their PBL and small-group programme. In 2010 PCMD was divided to create Plymouth University Peninsula Schools of Medicine and Dentistry (https://www.plymouth.ac.uk/schools/peninsula-school-of-medicine) and Exeter Medical School. The PBL courses of each school continues to develop and now uses an 8 step process, which is an evolution of the Maastricht 7 jump process.

Lake Erie College of Osteopathic Medicine (LECOM) offers a PBL pathway at the main campus in Erie, Pennsylvania. In 2004, LECOM founded a branch campus in Bradenton, Florida, using an entirely PBL format.

A satellite campus in Greensburg, Pennsylvania is also exclusively PBL.

In 2002, Gadjah Mada University of Yogyakarta, Indonesia began offering an International Medicine program based on problem-based learning.[26] Gazeira University in Sudan was the first in the country to adopt PBL in its medical college, a trend that was followed by some of the newer medical colleges. In 2008 the famous Faculty of Medicine of the University of Khartoum, which was following a traditional curriculum since its foundation in 1924 made a being change in curriculum structure by adopting a blend curriculum that incorporate problem solving learning strategies.

In 2008 Aljouf University (http://www.ju.edu.sa/en/Pages/default.aspx) of Sakakah, Saudi Arabia and Alfaisal University [Riyadh], [Saudi Arabia] started using PBL for all of their medical programmes.[27]

In 2009, Libyan International Medical University of Benghazi, Libya started using PBL for all of its medical programmes.[28]

High Schools

In 2008, Parramatta Marist High School, a secondary Catholic school in Australia, employed the methods of PBL in their teaching for year 9 and 10 boys. The learning system was a great success and since has been expanded to lower grades to challenge students to think outside of the box and relate content drive courses to problems in the real world.

North Lawndale College Prep High School (NLCP), on Chicago's west side, continues to refine its very high expectations Interdisciplinary Projects, or I-Projects (http://www.nlcphs.org/interdisciplinaryprojects/). As they progress freshman through senior year, these vertically aligned projects involve increasingly rigorous Common Core State Standards in research, close reading, quantitative reasoning, argumentation, writing, and presentation skills. Each NLCP Junior and Senior Project derives itself from the student's own driving question (examples of driving questions include "How can genocide be stopped globally?" and "Does making obesity a disease help or harm obese people?"). Additionally and starting in 2014, all NLCP Senior Project Presentations will include the senior's creation of an artistic element that somehow expresses his/her argument, e.g., a documentary film, a website, a business proposal, a literary portfolio, a visual art portfolio, a unique oratory, or performative debate. Noodletools (http://www.noodletools.com/), "a powerful, integrated platform for research and literacy," is the assistive technology for North Lawndale's endeavor.

Sir John Deane's College, a sixth form college in England, in 2013 offered an extracurricular PBL Course in Medicine positioned towards students studying A-Level Biology and Chemistry who are aspiring to medicine, dentistry, veterinary science degrees or biological sciences at Oxford or Cambridge. The course (developed by Dr. Vimalan Jesudason) successfully served 85 students, before being offered independently in late 2014, PBL Cheshire (http://pblcourse.co.uk/).

In Canada, North Peace Secondary School's Energetic Learning Campus (ELC) is based on this philosophy. It takes grade 10 and 11 students, and work through the core courses based on the Prescribed Learning Outcomes for the province of British Columbia. The ELC is a sub-campus of the secondary school and is located inside the Pomeroy Sports Centre. Students are guided through English, Math, Sciences, and Social Studies, along with physical activity.

Ecological Economics

The transdisciplinary field of ecological economics has embraced problem-based learning as a core pedagogy. A workbook developed by Joshua Farley, Jon Erickson, and Herman Daly organizes the problem-solving

process into (1) building the problem base, (2) analyzing the problem, (3) synthesizing the findings, and (4) communicating the results. Building the problem base includes choosing, defining, and structuring an ecological economic problem. Analysis is breaking down of a problem into understandable components. Synthesis is the re-integration of the parts in a way that helps better understand the whole. Communication is the translation of results into a form relevant to stakeholders, broadly defined as the extended peer community.[29]

Criticisms

Cognitive load

Sweller and others have published a series of studies over the past twenty years that is relevant to problem-based learning but concerning cognitive load and what they describe as the guidance-fading effect.[30] Sweller et al. conducted several classroom-based studies with students studying algebra problems.[31] These studies have shown that active problem solving early in the learning process is a less effective instructional strategy than studying worked examples (Sweller and Cooper, 1985; Cooper and Sweller, 1987). Certainly active problem solving is useful as learners become more competent, and better able to deal with their working memory limitations. But early in the learning process, learners may find it difficult to process a large amount of information in a short time. Thus the rigors of active problem solving may become an issue for novices. Once learners gain expertise the scaffolding inherent in problem-based learning helps learners avoid these issues. These studies have however been conducted largely based on individual problem solving of well-defined problems.

Sweller (1988) proposed cognitive load theory to explain how novices react to problem solving during the early stages of learning.[31] Sweller, et al. suggests a worked example early, and then a gradual introduction of problems to be solved. They propose other forms of learning early in the learning process (worked example, goal free problems, etc.); to later be replaced by completions problems, with the eventual goal of solving problems on their own.[32] This problem-based learning becomes very useful later in the learning process.

Many forms of scaffolding have been implemented in problem-based learning to reduce the cognitive load of learners. These are most useful to fade guidance during problem solving. As an example, consider the fading effect helps learners to slowly transit from studying examples to solving problems. In this case backwards fading was found to be quite effective and assisting in decreasing the cognitive load on learners.[33]

Evaluation of the effects of PBL learning in comparison to traditional instructional learning have proved to be a challenge. Various factors can influence the implementation of PBL: extent of PBL incorporation into curriculum, group dynamics, nature of problems used, facilitator influence on group, and the motivation of the learners. There are also various outcomes of PBL that can be measured including knowledge acquisition and clinical competence.[34][35] Additional studies are needed to investigate all the variables[34] and technological scaffolds,[36] that may impact the efficacy of PBL.

Demands of Implementing

Implementing PBL in schools and Universities is a demanding process that requires resources, a lot of planning and organization.[37] Azer discusses the 12 steps for implementing the "pure PBL"[37]

1. Prepare faculty for change
2. Establish a new curriculum committee and working group

3. Designing the new PBL curriculum and defining educational outcomes
4. Seeking Advice from Experts in PBL
5. Planning, Organizing and Managing
6. Training PBL facilitators and defining the objectives of a facilitator
7. Introducing Students to the PBL Program
8. Using 3-learning to support the delivery of the PBL program
9. Changing the assessment to suit the PBL curriculum
10. Encouraging feedback from students and teaching staff
11. Managing learning resources and facilities that support self-directed learning
12. Continuing evaluation and making changes (pg. 809-812)

Hung reviews the various models of PBL, Barrow's original concept or "pure PBL", the Hybrid PBL and lecture based learning with problem solving activities.[2] In general these models form a continuum where the level of instruction and lecture are inversely proportional to the amount of self-directed learning. The individual Problem design, or "trigger" must ultimately guide students to obtain the learning objectives. Azer reviews the detailed objectives for constructing "the problem" for PBL.[37] Facilitator selection, training and development is very important to PBL. Students respond better to motivated and enthusiastic facilitators.[38] It is the facilitator's role to direct students during the tutorials. Guiding students learning entails much more time then simply giving students the answers.[2] Kol et al.(2008) reported PBL facilitator-student contact time was 3-4 times greater than instructors in traditional methods.

Other outcomes

One of the aims of PBL is the development of self-directed learning (SDL) skills. In Loyens, Magda & Rikers' discussion, SDL is defined as "a process in which individuals take the initiative…in diagnosing their learning needs, formulating goals, identifying human and material resources, choosing and implementing appropriate learning strategies, and evaluating learning outcomes."[39] By being invited into the learning process, students are also invited to take responsibility for their learning, which leads to an increase in self-directed learning skills. In Severiens and Schmidt’s study of 305 first year college students, they found that PBL and its focus on SDL led to motivation for students to maintain study pace, led to social and academic integration, encouraged development of cognitive skills, and fostered more study progress than students in a conventional learning setting.[40] PBL encourages learners to take a place in the academic world through inquiring and discovery that is central to problem-based learning.

PBL is also argued as a learning method that can promote the development of critical thinking skills.[41] In PBL learning, students learn how to analyze a problem, identify relevant facts and generate hypotheses, identify necessary information/knowledge for solving the problem and make reasonable judgments about solving the problem.

Employers have appreciated the positive attributes of communication, teamwork, respect and collaboration that PBL experienced students have developed. These skills provide for better future skills preparation in the ever-changing information explosion. PBL curriculum includes building these attributes through knowledge building, written and interpersonal interactions and through the experience of the problem solving process.[42]

Advantages of problem-based learning

Like any other learning theories, problem-based learning too has its advantages and limitations when it is

implemented in the curriculum. Since this experiment began in medical education, strong opinions have been expressed and questions raised regarding the effectiveness and educational efficiency of problem-based learning approach in teaching sciences basic to medicine. Following are the advantages and limitations of problem-based learning.

Fosters student-centred learning

In problem-based learning the students are actively involved and they like this method.[43] It fosters active learning, and also retention and development of lifelong learning skills. It encourages self-directed learning by confronting students with problems and stimulates the development of deep learning.[44]

Upholds lifelong learning

Problem-based learning gives emphasis to lifelong learning by developing in students the potential to determine their own goals, locate appropriate resources for learning and assume responsibility for what they need to know.[45] (Candy PC. Self-direction for lifelong learning: a com¬prehensive guide to theory and practice. San Francisco: Jossey-Bass, 1991.). It also greatly helps them better long term knowledge retention.[46]

Prominence on comprehension not facts

Problem-based learning focuses on engaging students in finding solutions to real life situations and pertinent contextualized problems. In this method discussion forums collaborative research take the place of lecturing.

In-depth learning and constructivist approach

PBL fosters deep learning by involving students with the interaction of learning materials. They relate the concept they study with everyday activities and enhance their knowledge and understanding. Students also activate their prior knowledge and build on existing conceptual knowledge frameworks.[47]

Arguments self-learning

Students themselves resolve the problems that are given to them, they take more interest and responsibility for their learning. They themselves will look for resources like research articles, journals, web materials etc. for their purpose.[48] Thus it equips them with more proficiency in seeking resources in comparison to the students of traditional learning methods.

Better understanding and adeptness

By giving more significance to the meaning, applicability and relevance to the learning materials it leads to better understanding of the subjects learnt. When students are given more challenging and significant problems are given it makes them more proficient.[49] The real life contexts and problems makes their learning more profound, lasting and also enhance the transferability of skills and knowledge from the classroom to work.[50] Since there is more scope for application of knowledge and skills the transferability is increased. It will be also very helpful to them not only to visualise what it will be like applying that knowledge and expertise on their field of work or profession.[51]

Reinforces interpersonal skills and teamwork

Project based learning is more of teamwork and collaborative learning. The teams or groups resolve relevant problems in collaboration and hence it fosters student interaction, teamwork and reinforces interpersonal skills.[52] like peer evaluation, working with group dynamic etc.[53] It also fosters in them the leadership qualities, learn to make decision by consensus and give constructive feed back to the team members etc.[54]

Self-motivated attitude

Researchers say that students like problem-based learning classes rather than the traditional classes. The increase in the percentage of attendance of students and their attitude towards this approach itself makes it very clear that they are self-motivated.[55] In fact it is more fascinating, stimulating and one of the good learning methods because it is more flexible and interesting to students. They enjoy this environment of learning for it is less threatening and they can learn independently. All these aspects make students more self-motivated and they pursue learning even after they leave the school or college.[56]

Enriches the teacher-student relationship

Since the students are self-motivated, good teamwork, self-directed learning etc. the teachers who have worked in both traditional and project based learning formats prefer project based learning.[56] They also feel that problem-based learning is more nurturing, significant curriculum and beneficial to the cognitive growth of the student.[57]

Higher level of learning

The PBL students score higher than the students in traditional courses because of their learning competencies, problem solving, self-assessment techniques, data gathering, behavioral science etc.[58] It is because they are better at activating prior knowledge, and they learn in a context resembling their future context and elaborate more on the information presented which helps in better understanding and retention of knowledge.[59]

The limitations of problem-based learning

Time-consuming

Although students generally like and gain greater ability to solve real-life problems in problem-based learning courses, instructors of the methodology must often invest more time to assess student learning and prepare course materials, as compared to LBL instructors.[56]

Traditional assumptions of the students

The problem of the problem-based learning is the traditional assumptions of the students. Most of the students might have spent their previous years of education assuming their teacher as the main disseminator of knowledge. Because of this understanding towards the subject matter students may lack the ability to simply wonder about something in the initial years of problem-based learning.[60]

Role of the instructor

The instructors have to change their traditional teaching methodologies in order to incorporate problem-based learning. Their task is to question students' knowledge, beliefs, give only hints to correct their mistakes and guide the students in their research. All these features of problem-based learning may be foreign to some instructors; hence they find it difficult to alter their past habits.

Pupil's evaluation

The instructors have to adapt new assessment methods to evaluate the pupils' achievement. They have to incorporate written examinations with modified essay questions, practical examinations, peer and self assessments etc.

Information Overload

Since it is self-directed study the students may not be sure of how much self-directed study to do and what information is relevant and important unless they are properly guided by the instructors.[61]

Project based learning is one of the effective ways of delivering education. It has several advantages over traditional methods but at the same time few disadvantages. When we see in comparison with the traditional method the students from project based learning curriculum seem to have better knowledge retention and it also provides interesting and challenging educational atmosphere to students. Therefore, the beneficial effects of project based learning should not be underestimated. It can make students' learning experience very interesting and give students very fascinating or enthralling. [61]

P^5BL Approach

P^5BL stands for **P**eople, **P**roblem, **P**rocess, **P**roduct and **P**roject **B**ased **L**earning.

The **P^5BL approach** was a learning strategy introduced in Stanford School of Engineering in their P^5BL laboratory in 1993 as an initiative to offer their graduate students from the engineering, architecture and construction disciplines to implement their skills in a "cross-disciplinary, collaborative and geographically distributed teamwork experience."[62] In this approach, which was pioneered by Stanford Professor Ms. Fruchter, an environment across six universities from Europe, the United States and Japan along with a toolkit to capture and share project knowledge was developed.[63] The students (people) from the three disciplines were assigned a team project that works on solving a problem and delivering an end-product to a client.

The main stress of this approach is to have an inter-disciplinary integrated development of deliverables, in order to improve the overall competency and skills of the students. P^5BL mentoring is a structured activity that involves situated learning and constructivist learning strategies to foster the culture of practice that would extend beyond the university campus to real life. P^5BL is all about encouraging teaching and learning teamwork in the information age, by facilitating team interaction with professors, industry mentors and owners who provide necessary guidance and support for the learning activity.

Key advantages of this method are that it familiarizes students with real world problems and improves their confidence in solving these. It also improves their networking skills, thereby establishing rapport with key persons of the industry. They also learn the value of teamwork. The method also creates in them an appreciation of interdisciplinary approach.

The approach however needs due consideration of the mentoring provided to the students. Appropriate

scaffolding should be done by the mentors to ensure that students are successful in attaining their project goals to solve the problem. Communication between the team should also be open and constructive in nature for achieving the necessary milestones.

See also

- Active learning
- Collaborative learning
- Discovery learning
- Educational psychology
- Inquiry-based learning
- Learning by teaching (LdL)
- POGIL
- Project-based learning
- Sudbury school - K-12 school where students have complete responsibility for their own education, and the school is run by direct democracy in which students and staff are equals
- McMaster University
- McMaster University Medical School
- Minnesota State University, Mankato Masters Degree in Experiential Education
- Observational learning
- 21st century skills

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External links

- Interdisciplinary Journal of PBL (https://docs.lib.purdue.edu/ijpbl/) at Purdue
- North Lawndale College Prep High School's Interdisciplinary Projects (http://www.nlcphs.org/interdisciplinaryprojects/), Chicago, IL
- Problem Based Learning for College Physics (CCDMD) (http://pbl.ccdmd.qc.ca/resultat.php?action=prob_tous&he=768)
- Illinois Mathematics and Science Academy's Problem Based Learning Network (PBLN) (http://pbln.imsa.edu/)
- Problem-Based Learning the Four Core Areas (http://pbl4c.wordpress.com/) PBL4C

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